The Science Behind Climate Change:

How Scientists Study the Past to Prepare for the Future

A field trip for high school students to the
Isolab stable isotope laboratory at the University of Washington

Isolab
Department of Earth and Space Sciences
University of Washington

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Introduction

The impact of climate change on our society will be one of the primary cultural issues faced by today's high school students. Many students may be familiar with climatic changes that are predicted to occur over the next century, but most have little or no understanding of the how scientists have studied past changes to Earth's climate (paleoclimatology) to make predictions about the future. Learning how scientists study the past will give students a better understanding of how predictions about future climate change are made.

This packet has been designed to help high school teachers schedule and develop a field trip to the University of Washington's Isolab stable isotope laboratory, where students will learn about how scientists collect, prepare, and analyze various types of samples (ice and sediment cores, pollen records, and carbonate samples) in order to reconstruct the Earth's ancient climate.

The different sections of this packet will guide you through the process of planning an Isolab field trip, which includes:

1. Contacting the Isolab directors
2. Scheduling a date to visit Isolab
3. Organizing (with Isolab personnel) the contents of the field trip
4. Conducting pre- and post-tests to gauge how students' understanding of key paleoclimate concepts

Contacting Isolab to Arrange a Field Trip

Teachers wishing to arrange a field trip to Isolab should first contact Dr. Kate Huntington, who will help put you in contact with the rest of the Isolab staff and facilitate the scheduling and planning of the field trip.

Contact List

Primary Contact: Dr. Kate Huntington
kate1@uw.edu
206-543-1750

Isolab Manager: Andrew Schauer
aschauer@uw.edu
206-543-6327

Isolab Administrator: Erin Williamson
erinw271@uw.edu
206-543-6327

Isolab Paleoclimate Field Trip Planning Timeline

How far in advance	Task	Details
6 months	**Set Date**	
		contact Kate, Andy
3 months	**Contact Non-Isolab volunteers**	
		contact pollen person
		contact Mike
2 months	**Reserve Subs & Buses**	
		(teacher's duty)
		(if paying, PI may have paperwork)
1 month?	**Find chaperones**	
		(teacher's duty)
		~1 chaperone/5-6 students
1 month	**Find UW undergraduate volunteers**	
		-need 3 volunteers for 3 time slots (~9 people) (each time slot is 1 hour)
		-need 1 volunteer to direct traffic in the lobby
		-some way to motivate students would be great - in 2015, only 2 volunteers showed up total
1 month	**Find UW station leaders**	
		-1 pollen expert
		-1 ice core expert
		-1 sediment core/carbonate expert
		-1 carbonate reaction expert (reacting carbonate)
		-1 sample purificaiton expert (playing with cold liquids)
		-1 isotope measurement expert (probably Andy, measuring CO2 of breath)
1 month	**Reserve Rooms**	
		-Reserve a room in Allen research Commons for 3 hours, this is where the undergraduate panel happens
		-Contact Juliet Crider and Alison Duvall to reserve JHN 317
2 weeks	**In-person planning meeting**	

		-with teacher and UW volunteers/station leaders
		-finalize packet materials (may need customizing depending on the station leaders available)-
		-finalize rotation timeline
		-make sure the teacher knows the space
1 week	**Gather relevant station materials**	
		-cut an ice core
		-find a sediment core and other fancy carbonate samples
		-balloons, baking soda, vinegar
		-vials to breathe CO2 into
		-signs to label stations, point to research commons

Isolab Field Trip Planning Guide

Dr. Huntington and her graduate students will take the lead in recruiting volunteers to lead the different stations.

Station 1: Question and Answer Panel with College Students

Location: Allen Library Research Commons, Green Room A
Volunteers: 9 undergraduate/graduate college students (3 volunteers per 1 hr session)
Preparation: reserve Green Room A at least 72 hrs in advance (http://www.lib.washington.edu/commons/reserve/spaces)
Materials: NA
Description: Visiting students will have 55 minutes to ask the volunteer panelists questions about their college experiences. Panelists will be instructed to focus on why they chose to pursue a college education, what challenges they have faced as college students, and how they chose their field of study.

Station 2: Volcanoes and Climate (Lab Demonstration)

Location: Johnson Hall Courtyard (see Johnson Hall Map)
Volunteers: 2 (Michael Harrell, and 1 student)
Preparation: Contact Michael Harrell to arrange for demonstration (mdh666@uw.edu)
Materials: Large trash can, liquid nitrogen, water, 1 cinder block, plastic water bottles, duct tape (Michael Harrell will arrange all of this)
Description: The "cryo-volcano" is a fun activity that demonstrates the basic mechanisms of a volcanic eruption. Students will have the opportunity to ask Dr. Harrell about how volcanoes affect climate.

Station 3: Pollen Analysis

Location: 221 Johnson Hall (2nd floor)
Volunteers: 1
Preparation: Contact Dr. Estella Leopold (eleopold@u.washington.edu) to arrange for a member of her lab to direct the station
Materials:
Description:

Station 4: Ice Cores

Location: 303C Johnson Hall (3rd floor)
Volunteers: 1
Preparation: Confirm with Andy Schauer that an ice core section has been prepared for display.
Materials: 1 cut ice core to be displayed on the light box
Description: Visiting students will learn about how ice cores are collected and prepared for analysis, and what paleoclimate information can be learned from studying ice cores. Students will be shown an ice core sample, and learn how researchers determine the ages of an ice core. This station involves entering a large, walk-in freezer for ~5 minutes to view a prepared ice core sample.

Station 5: Sediment Cores and Carbonate

Location: 318 Johnson Hall (3rd floor)
Volunteers: 1-2

Preparation: Gather materials; email ESS personnel to locate sediment core/bone/bio-apatite samples

Materials: 1 sediment core/bone sample/bio-apatite, 2 scales (0.01 mg accuracy), carbonate powder, weighing tools, carbonate samples

Description: This station includes two components: 1) visiting students will learn about sediment cores (or bone or bio-apatite), including where and how these samples are collected and prepared for analysis, and what paleoclimate information they contain; and 2) students will learn about carbonate minerals, including the various types of carbonate samples that climate scientists collect, the paleoclimate information that can be recovered from such samples, and the first steps (powdering and weighing) of preparation carbonate samples for analysis.

Station 6: Acid Reaction and CO_2 Transfer

Location: 303 Johnson Hall (3rd floor)

Volunteers: 1

Preparation: Gather materials, reserve time on the vacuum line

Materials: 2 reaction vessels, baking soda, vinegar, balloons, and access to the clumped isotope vacuum line

Description: At this station, students will learn about how and why carbonate powders are dissolved to produce CO_2 gas prior to isotopic analysis.

Station 7: Purifying Sample

Location: 317 Johnson Hall (3rd floor)

Volunteers: 1

Preparation: Gather materials and have the key for Johnson 317

Materials: Liquid nitrogen, dry ice, 2 dewers, balloons, tongs, and 6 sample tubes containing CO_2, water, and vacuum.

Description: Students will learn about the process of sample purification, including how "cold traps" at different temperatures are used to isolate different gases (e.g., oxygen and CO_2). Additionally, students will learn why this purification process is a necessary step in isotope analysis.

Station 8: Isotope Measurement

Location: 302A Johnson Hall (3rd floor)

Volunteers: 1

Preparation: Confirm that Andy Schauer has reserved the necessary mass spectrometers

Materials: Screw-top tubes for students to breathe into, 1 syringe

Description: Students will learn about how isotope mass spectrometers work. Additionally, they will be able to collect their own breath samples and measure the isotopic composition of their own CO_2, and learn how scientists can use this isotopic information to learn about human diet.

Post-Field Trip to Stable Isotope Laboratory

Please help us understand and improve your experience on this field trip.

1. Indicate your level of agreement/disagreement with the following statements.

	Strongly Agree	Agree	Disagree	Strongly Disagree	N/A
It is possible for scientists to study ancient climate.	☐	☐	☐	☐	☐
I think climate is interesting.	☐	☐	☐	☐	☐
I want to learn more about science.	☐	☐	☐	☐	☐
I can imagine myself attending college.	☐	☐	☐	☐	☐
I can imagine myself majoring in a science field.	☐	☐	☐	☐	☐
I can imagine myself pursuing a career in science.	☐	☐	☐	☐	☐

2. Indicate how knowledgeable you feel about the following topics.

	1 Extremely knowledgeable	2 Quite knowledgeable	3 Moderately knowledgeable	4 Slightly knowledgeable	5 Not at all knowledgeable
The types of natural materials that scientists can use to study ancient climate	☐	☐	☐	☐	☐
How scientists use pollen to study ancient climate	☐	☐	☐	☐	☐
How scientists use ice cores to study ancient climate	☐	☐	☐	☐	☐
How scientists use sediment cores to study ancient climate	☐	☐	☐	☐	☐
The laboratory methods scientists use to measure the isotopic values of samples	☐	☐	☐	☐	☐

Student Field Trip Packets

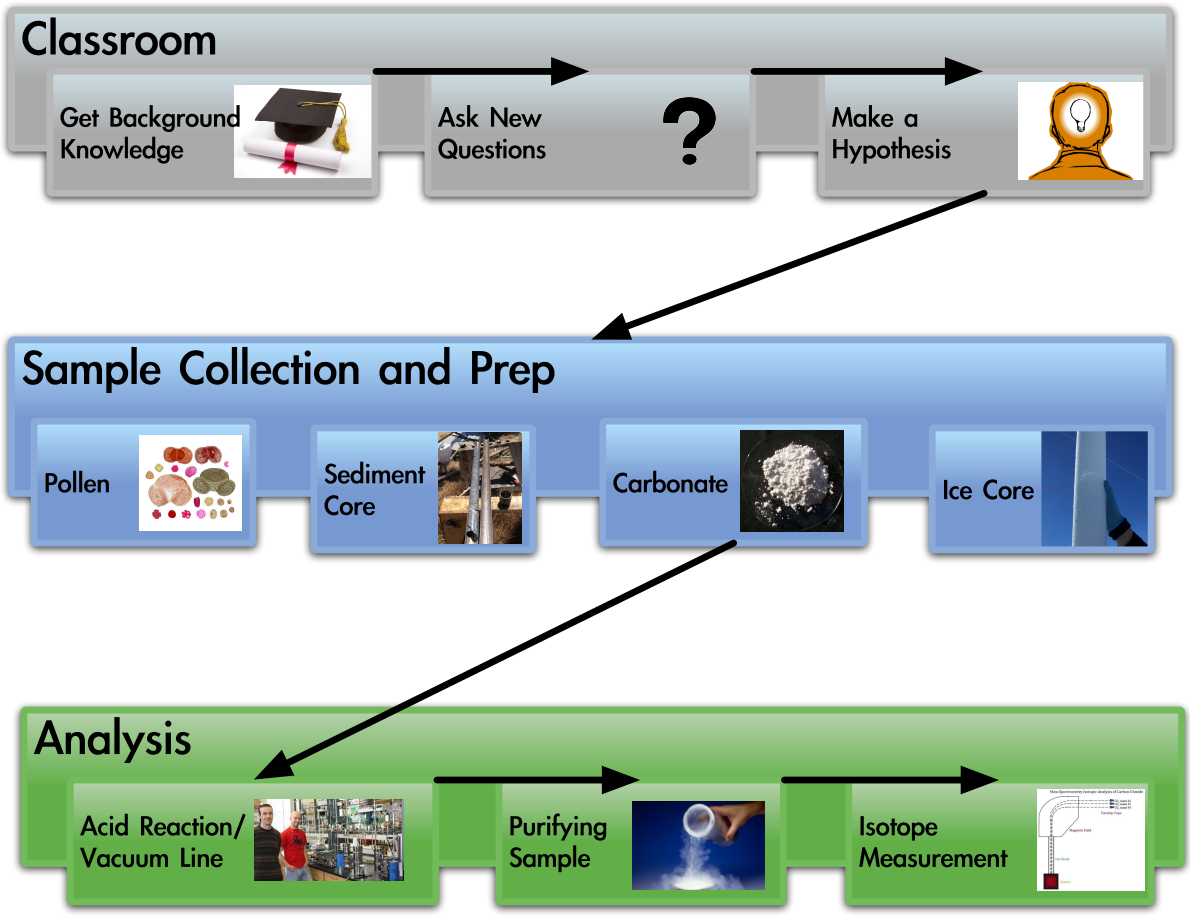
Paleoclimate Research

Field Trip to the Stable Isotopes Laboratory at University of Washington

Workbook • Hosted by Dr. Katharine Huntington • Date:_____

_____

Student Name



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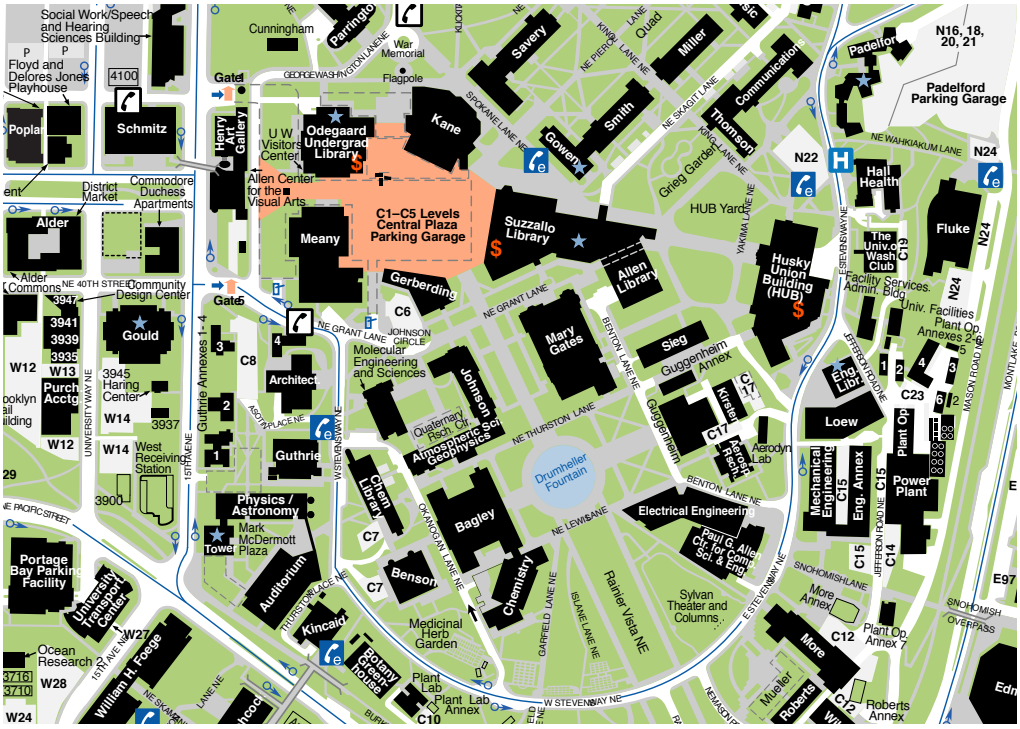
Planning

How will I know where to go?

MY ITINERARY

Time	9:00	9:20	9:40	10:00	10:20	10:40	11:00	11:20	11:40	12:00
Activity										lunch
Room										HUB

CAMPUS MAP



UW Campus

College Life

What is it like to be a student here?

STATION 1: QUESTION AND ANSWER WITH COLLEGE STUDENTS

1. Why did your guide choose to go to college?

2. What was one struggle he or she faced so far with college?

Sample Collection and Prep

Where do the samples come from? What do they look like?

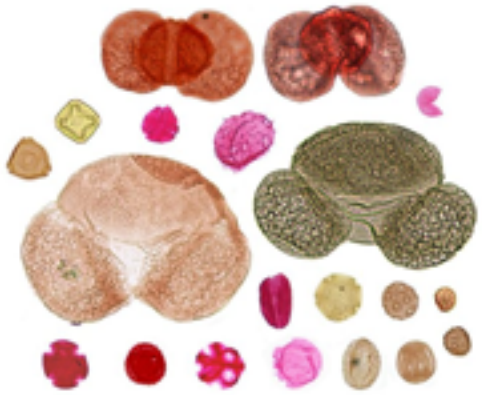
STATION 2: VOLCANOES AND CLIMATE

1. What is one way volcanic eruptions influence climate?

2. What is one thing that determines how explosive a volcanic eruption will be?

STATION 3: POLLEN ANALYSIS

221 Johnson Pollen Lab



Questions

1.How does pollen help scientists understand changes in climate?

2.What are some similarities and differences between our pollen lab in class and what you saw in the pollen lab here today?

STATION 4: ICE CORE

303C Johnson, hallway outside freezer

In places where it stays cold all year round and the snow never gets a chance to melt, large glaciers and ice sheets form over time. We know that the deeper down in the ice you go, the older the ice is, and we can analyze the gas trapped in the little air bubbles and the ice itself to get information about climate.

Questions

1.Where did this ice core come from?

2.What made that location a good one for studying?

3.How does ice help scientists understand changes in climate?

STATION 5a: SEDIMENT CORE

318 Johnson Erosion Lab

Sediment Cores are collected from the bottoms of lakes or oceans to analyze the information stored in the sediment. We know that the further down we go the older the material is, so we can use that to make a timeline and form conclusions about the data we collect, be that pollen data, carbonate data, or something different we find in the sediment.

Questions

1. Where did the sediment core come from?

2. What made that location a good one for studying?

3. How does lake sediment help scientists understand changes in climate?

Station 5b: CARBONATE

318 Johnson Erosion Lab

Carbonate can be collected in many ways because it is found in many things in the environment. Carbonate is in shells, can form on the bottoms of rocks, and can be collected from soils. No matter the source, you still need to collect enough sample for the next step, which is the acid reaction.

Questions

1. How accurate was the scale?

2. What was the white powder you were collecting?

3. What was the name of the tool you used?

4. What is the next step for the powder?

5. Why did you have to have a specific mass of white powder?

Carbonate Analysis

How do we get data from dirt?

STATION 6: ACID REACTION AND CO_2 TRANSFER

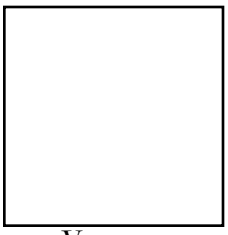
303 Johnson, Stable Isotopes - Sample Prep Lab

Carbonate minerals grow in the environment, and their isotopes record climate. Our instruments can't measure isotopes in solid carbonate, so we have to turn samples into CO2 gas to analyze. To do this, we react the carbonate with acid to release CO2 that we can analyze on a mass spectrometer.

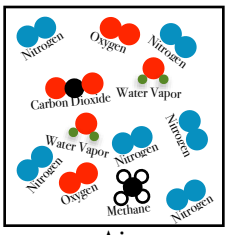
Vocabulary:

Vacuum- a space that is empty of matter

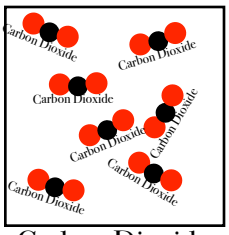
Air- A mixture of gas molecules



Vacuum



Air



Carbon Dioxide

Goal 1: React carbonate with acid to release the CO2 gas

Goal 2: Get the CO2 out of the reaction vessel without contaminating it with air.

Goal 3: Transfer the CO2 gas to a small tube that fits on the mass spectrometer to be measured.

Questions:

1. How do you turn your carbonate mineral sample into CO2 gas that you can measure?

2. How do you make sure your sample of gas doesn't get mixed with the atmosphere gas?

STATION 7: PURIFYING SAMPLE

317 Johnson

Moving around Carbon Dioxide gas without letting it escape or get contaminated with air is not easy. We use the different freezing points of the materials to move and purify our samples. This activity is designed to help you understand how we do that.

You will have 3 tubes. One is a tube of CO_2, one is water vapor, and the third is vacuumed empty. Use the information about freezing temperature below to deduce which tube contains which gas

1. Reference Data

Substance	Freezing Point
H	0°
CO	-78.5

2. Measuring Temperature

Liquid	Temperature	What would freeze at this temp?
ethanol/Dry Ice Slush (CO		
Liquid Nitrogen (N		

Tube	Did it freeze in:		What is the substance?
	Dry Ice	Liquid N	
A			
B			
C			

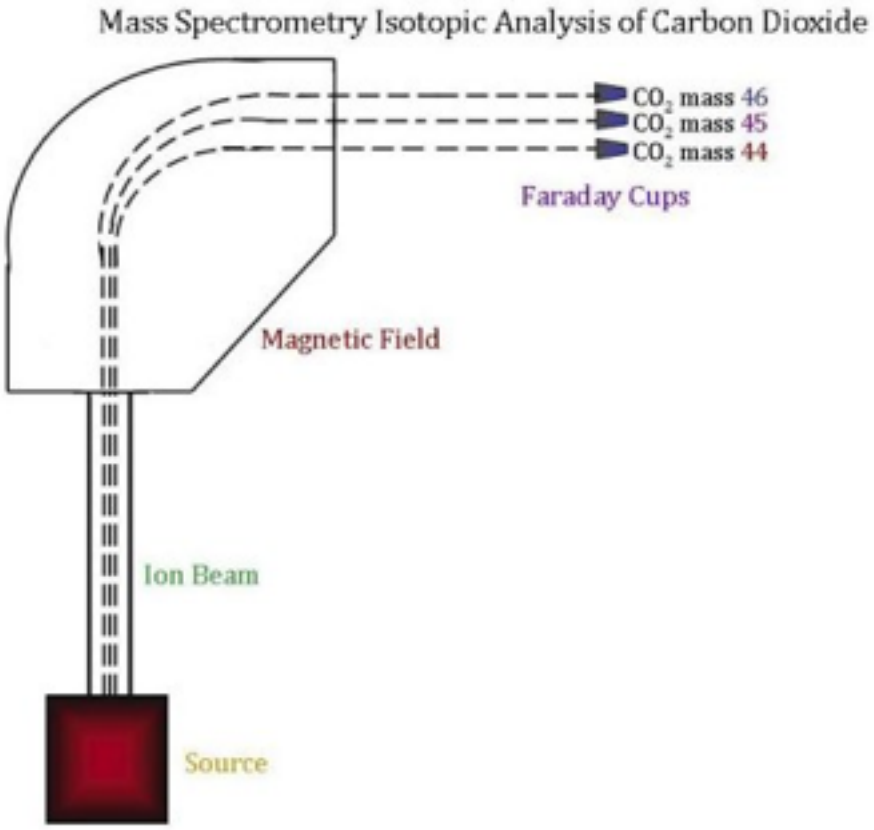
Questions

1.How did you know which tube was the CO_2?

STATION 8: ISOTOPE MEASUREMENT

302A Johnson, Stable Isotopes- Spectrometer Lab

This piece of equipment analyzes the gas we have collected to give us information about the isotopes. There is a direct relationship between isotopic levels and the temperature, so we can use the data from this machine to make conclusions about what the temperature was while each sample was forming. This combined with the knowledge of when the sample formed can allow us to build a picture of changes in climate over time.



Questions

1.What is an isotope?

2.What was the instrument you used to measure isotopes?

3.Where did you obtain carbon dioxide for this example?